

**UT to Fourth Creek Stream Mitigation Site  
Water Sampling and Benthic Macroinvertebrate Survey  
TIP I -3819A**

**Iredell County, North Carolina**

**Year 4 Monitoring Report**



*UT to Fourth Creek, Site 3 during 2018 survey*



**The North Carolina Department of Transportation  
Environmental Analysis and Permitting Unit**

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## TABLE OF CONTENTS

<b>1.0</b>	<b>INTRODUCTION.....</b>	<b>1</b>
<b>2.0</b>	<b>SITE DESCRIPTIONS .....</b>	<b>1</b>
<b>3.0</b>	<b>METHODOLOGY .....</b>	<b>2</b>
3.1	BMI Sampling.....	2
3.1.1	Field Methods .....	2
3.1.2	Water Chemistry .....	2
3.1.3	Sample Processing .....	2
3.1.4	Data Analysis .....	3
<b>4.0</b>	<b>RESULTS .....</b>	<b>3</b>
4.1	BMI Community Analysis .....	3
4.2	Physicochemical Analysis.....	3
4.3	Habitat Assessment Scores.....	4
<b>5.0</b>	<b>DISCUSSION/CONCLUSIONS.....</b>	<b>5</b>
<b>6.0</b>	<b>LITERATURE CITED .....</b>	<b>6</b>

Table 1.	BMI Analysis Metrics.....	3
Table 2.	Physicochemical Data.....	4
Table 3.	Habitat Assessment Scores .....	4
Table 4.	Baseline MY-00 (2014) and MY-01 (2015) Taxa list with indications of relative abundance for Sites 1-3. A=Abundant (>10), C=Common (3-9), and R=Rare (1-2).....	10
Table 5.	Baseline MY-02 Taxa list.....	12
Table 6.	Taxa richness and summary parameters, UT to Fourth Creek, Iredell County, North Carolina, May 2014 June 2015, and June 2016.....	16
Table 7.	Taxa list with indications of relative abundance, UT to Fourth Creek, Iredell County, North Carolina, June 2017.....	16

**Appendix A. Survey Site Location Map**

**Appendix B. Benthic Macroinvertebrate Survey Results**

**Appendix C. Site Photos (Sites 1-3)**

**Appendix D. Habitat Assessment Field Data Sheets and Benthos Collection Cards**

## 1.0 INTRODUCTION

The North Carolina Department of Transportation (NCDOT) is evaluating the benthic macroinvertebrate (BMI) community for the Unnamed Tributary (UT) to Fourth Creek Stream Mitigation Site, related to impacts associated with TIP I -3819A, in Iredell County, North Carolina. The project includes three sites in UT to Fourth Creek (Figure 1). Three Oaks Engineering (Three Oaks) conducted the MY-04 water sampling and benthic macroinvertebrate surveys on June 1, 2018. UT to Fourth Creek is a tributary to the South Yadkin River and is located within U.S. Geological Survey (USGS) Hydrologic Unit (HU) 03040102, and NC Division of Water Resources (NCDWR) sub-basin 03-07-06 of the Yadkin-Pee Dee River Basin.

## 2.0 SITE DESCRIPTIONS

Collections of benthic macroinvertebrates were made from three sampling locations: Site 1, Site 2, and Site 3 (Appendix A, Figure 1). The stream conditions of each site were very similar to the 2014 Monitoring Year (MY)-00 baseline, 2015 MY-01, 2016 MY-02, and 2017 MY-03 conditions. See Appendix C for MY-04 site photos.

**Site 1.** Site 1 was the most upstream site located on UT to Fourth Creek. Stream conditions were very similar to the 2017 surveys. The top of bank width ranged from two to three meters (m) while wetted width was estimated to be one m. The bank height was approximately three m from the deepest part of the channel to the top of bank, with a water depth ranging from 0.1 to 0.25 m. Flow conditions were moderate, and the channel was wetted, with some substrate exposed. The habitat consisted of a riffle/pool/run sequence. Substrate was composed of cobble, gravel, sand, and silt. No aquatic vegetation was present (Appendix C, Photos 1 and 2). The riparian canopy on the left descending bank was narrow with mature trees, shrubs, and grasses, while the right descending side was relatively wide comparatively.

**Site 2.** Site 2 was located approximately 200 m downstream of Site 1. The stream was moderately channelized and very narrow. The top of bank width was estimated 0.75m while stream wetted width was approximately 0.5 m. The bank height from the deepest part of the channel to the top of bank was approximately 0.5 m, while water depth ranged from 0.25 to 0.5 m. Flow conditions were normal, and the channel was wetted, with little to no substrate exposed. In-stream habitat consisted of a riffle/pool/run sequence with a substrate composed mainly of sand with some gravel and silt. There was very little aquatic vegetation (Appendix C, Photos 3 and 4). In contrast to Site 1 and Site 3, the riparian buffer was composed mostly of grasses with only partial canopy shading by black willow saplings and herbaceous vegetation.

**Site 3.** Site 3 was the most downstream sampling site, approximately 600 m downstream of Site 2 and just downstream of Interstate 40. The top of bank width was approximately four m and stream wetted width ranged from two to three m. Bank height from the deepest part of the channel to the top of bank was approximately three m and stream depth ranged from 0.25 to 0.5 m. The stream banks exhibited moderate signs of erosion. Flow conditions were normal, and the channel was wetted, with little to no substrate exposed. Substrate was made up primarily of cobble, gravel, and sand with some silt present. Instream habitat consisted of a riffle/pool/run

sequence (Appendix C, Photos 5 and 6). The riparian buffer was more mature and much wider than the other two sites, providing shade throughout.

### **3.0 METHODOLOGY**

#### **3.1 BMI Sampling**

The BMI and water quality MY-04 surveys were conducted by Lizzy Stokes-Cawley, Evan Morgan, and Paige Green for all sites on June 1, 2018.

##### *3.1.1 Field Methods*

Water quality monitoring programs have been implemented by North Carolina Department of Environmental Quality (NCDEQ, formerly the NC Department of Environment and Natural Resources, NCDENR) Division of Water Resources (NCDWR) to assess water quality trends in North Carolina. One method used is the monitoring of BMI, or benthos, to assess water quality by sampling for selected organisms. The species richness and overall biomass, as well as the presence of various benthic groups intolerant of water quality degradation, are reflections of water quality.

Sites were sampled one time utilizing methodology described in the NCDWR's *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates, Version 5.0* (NCDEQ 2016). All sites were sampled utilizing the NCDWR Qual 4 collection method with the addition of a log wash with a fine mesh sampler. Qualitative collections of aquatic macroinvertebrates were made with D-frame aquatic dip nets, kick nets, a #30 sieve sand sample, and hand picking organisms from substrates. A multiple habitat approach was used, where specimens from all available habitats (stream margins, leaf packs, aquatic vegetation, detritus, woody debris and logs, and sand accumulations) were combined to form one aggregate sample. Samples were preserved in the field with 90% ethyl alcohol and delivered to Eaton Scientific on June 1, 2018. Habitat scores were determined using the Habitat Assessment Field Data Sheet for Mountain/Piedmont Streams (Appendix D). Benthos Collection Cards are also included (Appendix D).

##### *3.1.2 Water Chemistry*

Water chemistry was measured at each site in conjunction with BMI sampling. Parameters measured were temperature, dissolved oxygen (DO), specific conductivity, and pH (Table 2).

##### *3.1.3 Sample Processing*

BMI were sorted from debris, counted, and identified to the lowest taxonomic level with microscopic techniques and taxonomic keys (Tables 4 and 5, Appendix B). Eaton Scientific maintained the collected specimens. Please note that a different company was used to determine benthic species for MY-02, therefore, the results are presented in a different format from 2016 MY-02.

### 3.1.4 Data Analysis

Analysis of, and comparison between, the BMI communities at each site were determined with established indices and metrics described in the *Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates, Version 5.0* (NCDEQ 2016). The metrics used in this evaluation included the total taxa richness, Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa richness, EPT Abundance, and NC Biotic Index (BI) assigned value (Table 1). Other information used in the analysis included Habitat Assessment Field Data Sheet scores, observations, and best professional judgment (Table 3). The primary output was a taxa list, with total number of organisms, total number for each taxon, EPT index, and assigned BI values.

Several data-analysis summaries (metrics) can be produced from such samples to evaluate biological conditions. These metrics are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted or otherwise stressed streams have fewer numbers of invertebrate taxa and are dominated by tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts; the tolerance of the stream community is evaluated using a BI.

Total taxa, EPT taxa richness, and BI values were compared between sites and monitoring year. In general, higher EPT taxa richness values and lower BI values usually indicate better stream quality. BI ratings range from 1-10 with a score of 1 generally reflecting high stream quality based on benthic macroinvertebrate diversity and habitat availability, while a higher score generally reflects lower stream quality.

## 4.0 RESULTS

### 4.1 BMI Community Analysis

The taxa list, analysis metrics, and additional laboratory data are presented in Appendix B. Table 1 compiles the analysis metrics created from data collected from 2014 through 2018.

**Table 1. BMI Analysis Metrics**

Sampling Year	Baseline MY-00 (2014)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-04 (2018)		
Site	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Total Taxa Richness	31	32	40	17	38	26	39	52	55	23	18	27	18	26	35
EPT Taxa Richness	11	7	10	8	8	7	12	12	11	6	2	7	6	4	7
Biotic Index Value	4.7	5.8	6.1	4.5	5.6	5.6	5.5	5.7	6.1	4.9	5.1	5.7	5.0	5.7	5.6

### 4.2 Physicochemical Analysis

Water chemistry data measured are listed in Table 2.

**Table 2. Physicochemical Data**

Sampling Year	Baseline MY-00 (2014)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-04 (2018)		
Site	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Water Temp (°C)	18.6	18.9	20.7	20.3	19.9	24.5	22.0	21.9	24.4	18.6	19.3	25.5	17.3	17.4	23.1
pH	8*	7.18*	7.43	7.85	7.1	7.3	6.95	6.90	7.85	8.1	6.75	7	7.06	6.69	7.55
Dissolved Oxygen (DO) (mg/L)	9.6	9.08	8.4	8.13	8.8	7.02	8.07	8.40	8.28	8.2	9.5	7.5	11.48	10.35	9.6
Specific Conductivity (uS/cm)	197.3	202.0	110.0	193.2	193.4	106.2	193.2	189.3	129.7	200.8	192.5	102.7	188.3	190.3	98.0

\*Re-measured on 5/23/14 due to pH probe malfunction

### 4.3 Habitat Assessment Scores

Habitat scores were determined using the Habitat Assessment Field Data Sheet for Mountain/Piedmont Streams and are shown in Table 3. These visual-based habitat evaluation scores consist of eight parameters that rate channel modification, instream habitat, bottom substrate, pool variety, riffle habitat, bank stability and vegetation, light penetration, and riparian vegetation zone width for each sampling reach. A numerical score is used to rate each parameter and the total score gives a relative measure of overall habitat quality (Appendix D).

**Table 3. Habitat Assessment Scores**

Sampling Year	Baseline MY-00 (2014)			MY-01 (2015)			MY-02 (2016)			MY-03 (2017)			MY-04 (2018)			Maximum Points
Site	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Channel Modification	5	3	4	5	4	4	5	4	4	4	4	4	4	4	4	15
Instream Habitat	16	10	16	16	10	16	16	10	16	16	10	16	16	10	16	20
Bottom Substrate	12	3	11	11	3	11	11	3	11	11	3	14	12	3	12	15
Pool Variety	6	4	8	10	6	10	10	6	10	10	6	10	10	6	10	10
Riffle Habitats	14	3	7	16	7	14	16	7	14	16	7	14	14	7	16	16
Bank Stability and Vegetation	11	4	12	13	8	13	13	11	13	13	11	13	13	11	13	14
Light Penetration	8	2	10	10	7	10	10	7	10	10	7	10	10	7	10	10
Riparian Vegetation Zone Width	5	0	10	5	10	10	5	10	10	10	10	10	10	9	10	10
Total	77	29	78	86	55	88	86	58	86	90	58	91	89	57	91	100

## 5.0 DISCUSSION/CONCLUSIONS

The benthic macroinvertebrate fauna was analyzed to produce BI values; physiochemical properties and habitat were measured to assess site quality. The 2018 MY - 04 BI values range from 5.0 to 5.7 (mean 5.4), which indicate slight improvement over the baseline (mean 5.5) and MY - 02 (mean 5.8). The three monitoring sites during MY-01 and MY- 03 indicate additional improvement (mean 5.2) from the baseline.

Water quality parameters measured were temperature, pH, DO, and specific conductivity. According to the NCDEQ and U.S. Environmental Protection Agency (EPA) Water Quality Standards Table, all sites have pH and DO levels within the appropriate range for freshwater aquatic life. The pH range for freshwater aquatic wildlife is between 6 and 9 (NCDENR 2013), Sites 1-3 ranged from 6.69 - 7.55. The pH range in 2018 was consistent with previous monitoring years where values have fallen between 6.75 and 8.1 and have all been in appropriate range for freshwater aquatic life. The DO levels for all sites were above the minimum standard of 5.0 mg/L ranging from 9.6 – 11.48 mg/L (NCDENR 2013). DO levels were higher than previous monitoring years at all three sites; DO has consistently been above the minimum standard in all monitoring years. Specific conductivity readings within rivers in the United States generally range from 50 to 1500  $\mu\text{S}/\text{cm}$  (EPA 2012). Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a specific conductivity range between 150 and 500  $\mu\text{S}/\text{cm}$  (EPA 2012). Sites 1-3 had results between 98.0 – 190.3  $\mu\text{S}/\text{cm}$ . Site 1 and Site 2 had specific conductivity readings of 188.3  $\mu\text{S}/\text{cm}$  and 190.3  $\mu\text{S}/\text{cm}$ , respectively, values which fall into the range for streams supporting good mixed fisheries. Conductivity readings were similar to previous monitoring years. Overall the water chemistry results are similar to previous monitoring years, with significant improvements to DO measurements noted in 2018.

Habitat assessment scores reflect higher quality habitats at Sites 1 and 3, and lower quality habitat in Site 2. Canopy and instream habitat availability for benthic colonization are sparse within Site 2. Based on habitat assessment scores, habitat has improved from Baseline MY- 00 at all three sites.

This data provides baseline and post construction conditions for aquatic community parameters in the project area that can be used to monitor changes in water quality over time.

## **6.0 LITERATURE CITED**

NC Department of Environment and Natural Resources (NCDENR). 2013. North Carolina Surface Waters and Wetland Standards (NC Administrative Code 15A NCAC 02B. .0100 & .0200) Amended Effective April 1, 2003.

NC Department of Environmental Quality (NCDEQ). 2016. Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates, Version 5.0. Division of Water Resources. Raleigh, North Carolina. February 2016.

U.S. Environmental Protection Agency (EPA). 2012. Water: Monitoring & Assessment. 5.9 Conductivity. What is conductivity and why is it important?  
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**Appendix A.**

**BMI Survey Site Location Map**



**Appendix B.**  
**Benthic Macroinvertebrate Survey Results**

**Table 4. Baseline MY-00 (2014) and MY-01 (2015) Taxa list with indications of relative abundance for Sites 1-3. A=Abundant (>10), C=Common (3-9), and R=Rare (1-2).**

Site:	2014			2015		
	1	2	3	1	2	3
<b>EPHEMEROPTERA</b>						
<i>Maccaffertium modestum</i>	A	A	C	A	A	A
<i>Baetis flavistriga</i>	R	-	R	-	-	-
<i>Baetis intercalaris</i>	R	-	C	-	-	R
<i>Baetis pluto</i>	A	A	C	A	C	-
<i>Labioabaetis frondale</i>	C	R	-	-	R	-
<i>Labioabaetis propinquum</i>	-	R	C	-	R	-
<i>Callibaetis</i> sp	-	-	-	R	-	-
<i>Eurylophella verisimilis</i>	R	C	-	-	-	-
<b>PLECOPTERA</b>						
<i>Eccoptura xanthenes</i>	-	-	R	-	-	-
<i>Amphinemura</i> sp	-	-	C	-	-	-
<b>TRICHOPTERA</b>						
<i>Cheumatopsyche</i> spp	R	-	A	C	A	C
<i>Hydropsyche betteni</i>	C	-	A	C	C	A
<i>Diplectrona modesta</i>	C	-	-	C	C	-
<i>Chimarra</i> sp	-	-	-	A	A	C
<i>Oecetis persimilis</i>	-	-	R	-	-	-
<i>Neophylax atlanta</i>	A	-	-	A	-	-
<i>Pycnopsyche</i> sp	R	R	-	-	-	R
<i>Ironoquia punctatissima</i>	-	R	-	-	-	-
<i>Lype diversa</i>	-	-	-	-	-	R
<b>COLEOPTERA</b>						
<i>Macronychus glabratus</i>	-	-	C	-	-	C
<i>Stenelmis</i> sp	-	-	R	-	C	C
<i>Helichus</i> spp	R	C	-	-	R	-
<i>Anchytarsus bicolor</i>	-	-	R	-	-	C
<i>Neoporus</i> spp	R	C	-	-	C	-
<i>Dineutus</i> sp	-	-	C	-	-	R
<i>Cymbiodyta</i> sp	-	-	-	-	R	-
<b>ODONATA</b>						
<i>Calopteryx</i> sp	A	C	C	-	A	R
<i>Gomphus</i> sp	-	-	R	-	-	-
<i>Lanthus</i> sp	-	-	-	-	R	-
<i>Baesiaeschna janata</i>	-	-	C	-	-	-
<i>Boyeria vinosa</i>	-	-	R	-	C	C
<i>Cordulegaster</i> sp	-	-	-	-	R	-
<b>MEGALOPTERA</b>						
<i>Nigronia serricornis</i>	-	-	R	R	-	C
<i>Corydalus cornutus</i>	-	-	R	-	-	R
<b>DIPTERA: MISC.</b>						
<i>Dicranota</i> sp	C	R	R	R	R	-
<i>Anthocha</i> sp	-	-	-	R	-	-
<i>Hexatoma</i> sp	-	-	R	-	-	-
<i>Pseudolimnophila</i> sp	R	C	-	-	R	-

	Site:	2014			2015		
		1	2	3	1	2	3
<i>Simulium</i> spp		A	A	A	R	C	A
<i>Dixa</i> spp		A	R	C	-	C	R
<i>Muscidae</i> ( <i>Limnophora</i> ?)		-	C	-	-	-	-
Empididae		-	-	-	-	R	-
DIPTERA: CHIRONOMIDAE							
<i>Conchapelopia</i> group		C	C	C	C	A	R
<i>Zavrelimyia</i> sp		-	R	-	R	-	-
<i>Brillia</i> sp		R	-	-	-	-	-
<i>Cricotopus annulator</i> Gr		C	C	-	-	-	-
<i>Orthocladus obumbratus</i>		R	A	-	-	-	-
<i>Paraphaenocladus</i> sp		-	R	-	-	-	-
<i>Parametriocnemus lundbecki</i>		C	-	-	R	A	C
<i>Tvetenia bavarica</i> gr		-	-	R	-	R	-
<i>Eukiefferiella claripennis</i> gr		R	R	-	-	-	-
<i>Odontomesa fulva</i>		C	C	-	-	-	-
<i>Chironomus</i> sp		C	C	R	R	C	-
<i>Cryptochironomus</i> spp		-	R	R	-	C	-
<i>Microtendipes</i> sp		-	-	-	-	R	-
<i>Paratendipes</i> sp		R	C	-	-	R	-
<i>Phaenopsectra obediens</i> gr		-	C	R	-	R	-
<i>Phaenopsectra</i> sp		-	-	-	-	R	-
<i>Polypedilum flavum</i>		C	R	C	-	A	C
<i>Polypedilum tritum</i>		R	-	R	-	-	-
<i>Polypedilum fallax</i>		-	R	-	-	-	-
<i>Polypedilum illinoense</i>		-	-	-	-	R	-
<i>Stenochironomus</i> sp		-	-	-	-	-	R
<i>Stictochironomus</i> sp		C	-	-	-	C	-
<i>Tribelos jucundum</i>		-	-	R	-	-	-
<i>Micropsectra</i> sp		C	C	-	-	C	-
<i>Paratanytarsus</i> sp		-	-	R	-	-	-
<i>Rheotanytarsus</i> spp		-	-	R	-	-	R
OLIGOCHAETA							
<i>Stylaria lacustris</i>		-	-	R	-	-	-
<i>Ecclipidrilus</i> spp		-	-	R	-	-	-
CRUSTACEA							
<i>Caecidotea</i> sp (small)		-	C	R	-	R	R
<i>Cambarus</i> spp		-	-	A	R	-	A
MOLLUSCA							
<i>Corbicula fluminea</i>		-	-	A	-	-	A
-							
OTHER							
Hirudinea							
<i>Placobdella parasitica</i>		-	-	R	-	-	-
Hemiptera							
Corixidae		-	-	-	-	R	-

**Table 5. 2016 Baseline MY-02 Taxa list.**

STATION			SITE 1	SITE 2	SITE 3
SPECIES	T.V.	F.F.G.			
<b>MOLLUSCA</b>					
<b>Bivalvia</b>					
<b>Veneroida</b>					
<b>Corbiculidae</b>					
<i>Corbicula fluminea</i>	6.6	FC			6
<b>Gastropoda</b>					
<b>Mesogastropoda</b>					
<b>Pleuroceridae</b>	2.7				
<i>Elimia proxima</i>	2.7	SC			9
<b>Basommatophora</b>					
Ancylidae		SC			
<i>Ferrissia rivularis</i>	6.6	SC			1
<b>ANNELIDA</b>					
<b>Clitellata</b>					
<b>Oligochaeta</b>		CG			
<b>Tubificida</b>					
<b>Naididae</b>					
Naidinae		CG			1
<i>Nais behningi</i>	8.7	CG			2
<i>Nais communis</i>	8.7	CG		1	2
<i>Nais sp.</i>	8.7	CG			1
Tubificinae w.h.c.		CG			2
Tubificinae w.o.h.c.		CG	1		9
<b>Pristininae</b>					
<i>Pristina sp.</i>	7.7	CG		1	2
<b>ARTHROPODA</b>					
<b>Arachnoidea</b>					
Acariformes				3	2
<b>Sperchontidae</b>					
<i>Sperchon sp.</i>					1
<b>Crustacea</b>					
<b>Isopoda</b>					
<b>Asellidae</b>		SH			
<i>Caecidotea sp.</i>	8.4	CG	3	1	
<b>Decapoda</b>					
Cambaridae			16		
<i>Cambarus sp.</i>	7.5	CG	2	11	3

STATION			SITE 1	SITE 2	SITE 3
<i>SPECIES</i>	T.V.	F.F.G.			
<b>Insecta</b>					
<b>Collembola</b>					
Isotomidae			3	8	
<b>Ephemeroptera</b>					
Baetidae		CG	3		2
<i>Acentrella sp.</i>	2.5	CG	1		
<i>Baetis sp.</i>		CG		2	
<i>Baetis intercalaris</i>	5	CG		2	5
<i>Baetis pluto</i>	3.4			2	
<i>Labobaetis sp.</i>		CG		1	1
Ephemerellidae		SC	1		
Heptageniidae		SC	4		13
<i>Maccaffertium sp.</i>		SC	59	34	30
Leptophlebiidae		CG		3	
<b>Odonata</b>					
Aeshnidae		P			1
Calopterygidae		P			
<i>Hetaerina sp.</i>	4.9	P	8	25	20
<b>Coenagrionidae</b>		<b>P</b>			
<i>Argia sp.</i>	8.3	P			2
Cordulegastridae		P			
<i>Cordulegaster sp.</i>	5.7	P	1	1	
Gomphidae		P		1	1
<i>Progomphus obscurus</i>	8.2	P		1	2
<i>Stylogomphus albistylus</i>	5	P	2	4	
<b>Hemiptera</b>					
Veliidae		P	1	2	
<i>Rhagovelia obesa</i>		P	3		
<b>Trichoptera</b>					
Hydropsychidae		FC	22		13
<i>Cheumatopsyche sp.</i>	6.6	FC			17
<i>Diplectrona modesta</i>	2.3	FC	8	8	
<i>Hydropsyche depravata gp.</i>	7.9	FC		1	14
<i>Hydropsyche sp.</i>		FC	2	1	19
Lepidostomatidae		SH			
<i>Lepidostoma sp.</i>	1	FC	11	3	
Leptoceridae		CG			1
Philopotamidae		FC			
<i>Chimarra aterrima</i>	3.3	FC	27	7	7
<i>Dolophilodes distinctus</i>	1	FC	1		
<b>Psychomyiidae</b>		<b>CG</b>			

STATION			SITE 1	SITE 2	SITE 3
SPECIES	T.V.	F.F.G.			
<i>Lype diversa</i>	3.9	SC	2		
<b>Rhyacophilidae</b>		<b>P</b>			
<i>Rhyacophila carolina</i>	0.4	P		1	
<b>Coleoptera</b>					
<b>Dryopidae</b>					
<i>Helichus sp.</i>	4.1	SC		1	
<b>Elmidae</b>		<b>CG</b>			
<i>Macronychus glabratus</i>	4.7	SH			5
<i>Optioservus sp.</i>	2.1	SC			1
<i>Stenelmis sp.</i>	5.6	SC	5	4	6
<b>Ptilodactylidae</b>		<b>SH</b>			
<i>Anchytarsus bicolor</i>	2.4	SH			3
<b>Diptera</b>					
<b>Ceratopogonidae</b>		<b>P</b>			
<i>Atrichopogon sp.</i>	6.1	P	2		
<b>Chironomidae</b>					
<i>Ablabesmyia mallochi</i>	7.4	P			7
<i>Conchapelopia sp.</i>	8.4	P	30	35	18
<i>Corynoneura sp.</i>	5.7	CG	3	2	5
<i>Cryptochironomus sp.</i>	6.4	P			1
<i>Eukiefferiella sp.</i>		CG	2		
<i>Eukiefferiella claripennis gp.</i>	6.2	CG	2	1	
<i>Nilotanytus fimbriatus</i>	4.1				2
<i>Odontomesa fulva</i>	4.9			1	
<i>Paracladopelma sp.</i>	6.3	CG			1
<i>Parametriocnemus sp.</i>	3.9	CG	10	15	14
<i>Paratanytarsus dissimilis</i>	8				1
<i>Paratendipes albimanus/duplicatus</i>	5.6			2	
<i>Phaenopsectra obediens gp.</i>	6.6	SC	40	2	1
<i>Phaenopsectra punctipes gp.</i>	7.1	SC	2		
<i>Polypedilum fallax gp.</i>	6.5	SH		1	
<i>Polypedilum flavum</i>	5.7	SH	3	15	20
<i>Polypedilum illinoense gp.</i>	8.7	SH	10	4	
<i>Pseudosmittia sp.</i>		CG		1	
<i>Rheotanytarsus exiguus gp.</i>	6.5	FC	13	16	14
<i>Rheotanytarsus pellucidus</i>	6.5	FC		2	
<i>Rheocricotopus robacki</i>	7.9	CG			4
<i>Stenochironomus sp.</i>	6.3	SH			6
<i>Tanytarsus sp.</i>	6.6	FC	3	5	1
<i>Thienemanniella xena</i>	8	CG			1
<i>Tribelos jucundum</i>	5.7				1

STATION			SITE 1	SITE 2	SITE 3
SPECIES	T.V.	F.F.G.			
<i>Zavrelimyia sp.</i>	8.6	P	2	1	2
<b>Dixidae</b>		<b>CG</b>			
<i>Dixa sp.</i>	2.5	CG	1	2	1
Dolichopodidae		P		2	
Empididae		P		1	
<i>Hemerodromia sp.</i>		P		1	5
<b>Psychodidae</b>		<b>CG</b>			
<i>Pericoma sp.</i>		CG		2	
Sciaridae				1	
Simuliidae		FC			
<i>Simulium tuberosum</i>	4.9	FC		9	4
Tabanidae		PI			
<i>Tabanus sp.</i>	8.5	PI			1
Tipulidae		SH		1	
<i>Dicranota sp.</i>	0	P	1	6	
<i>Limnophila sp.</i>		P			1
<i>Pseudolimnophila sp.</i>	6.2	P	17	15	
<i>Tipula sp.</i>	7.5	SH		1	
TOTAL NO. OF ORGANISMS			327	273	315
TOTAL NO. OF TAXA			39	52	55
EPT INDEX			12	12	11
<b>NCBI Assigned values</b>			<b>5.48</b>	<b>5.67</b>	<b>6.09</b>

**Table 6. Taxa richness and summary parameters, UT to Fourth Creek, Iredell County, North Carolina, May 2014, June, 2015, and June 2016.**

	2014			2015			2016		
	1	2	3	1	2	3	1	2	3
Ephemeroptera	6	5	5	3	4	2	66	42	49
Plecoptera	-	-	2	-	-	-	-	-	-
Trichoptera	5	2	3	5	4	5	73	21	71
Coleoptera	2	2	4	-	4	4	5	5	15
Odonata	1	2	4	-	4	2	11	32	26
Megaloptera	-	-	2	1	-	2	-	-	-
Diptera; Misc.	4	6	5	4	6	3	2	-	-
Diptera: Chironomidae	13	14	10	4	13	5	120	103	99
Oligochaeta	-	-	2	-	-	-	1	2	19
Crustacea	-	1	2	-	2	2	21	12	3
Mollusca	-	-	1	-	-	1	-	-	6
Other	-	-	1	-	1	-	45	67	37
Total Taxa Richness	31	32	41	17	38	26	327	273	315
EPT Taxa Richness	11	7	10	8	8	7	39	52	55
NC Biotic Index	4.7	5.8	6.1	4.5	5.6	5.6	5.5	5.7	6.9
Bioclassification (Small stream*)	G	G-F	F	G	G-F	G-F	G-F	G-F	F

\*Assumes permanent flow, unlikely for these streams. Sites 2 and 3 fall right on the dividing line between Good-Fair and Fair; they are not significantly different.  
G=Good, G-F=Good-Fair, F=Fair

**Table 7. Baseline MY-03 (2017) Taxa list with indications of relative abundance for Sites 1-3. A=Abundant (>10), C=Common (3-9), and R=Rare (1-2).**

<u>Taxa / UT Fourth Cr</u>	<u>1</u>	<u>2</u>	<u>3</u>
EPHEMEROPTERA			
Family Baetidae			
<i>Baetis intercalaris</i> (5.0)	-	-	C
<i>Baetis pluto</i> (3.4)	C	-	-
<i>Pseudocloeon frondalis</i> (4.6)	-	R	R
Family Heptageniidae	-	-	-
<i>Maccaffertium modestum</i> (5.7)	A	R	A
PLECOPTERA			
Family Perlidae	-	-	R
TRICHOPTERA			
Family Hydropsychidae			
<i>Cheumatopsyche</i> spp (6.6)	C	-	A
<i>Diplectrona modesta</i> (2.3)	A	-	-
<i>Hydropsyche betteni</i> (7.9)	-	-	A
Family Limnephilidae			

<i>Neophylax atlanta</i>	A	-	-
Family Philopotamidae			
<i>Chimarra spp (3.3)</i>	A	-	A
MISC DIPTERA			
Family Culicidae			
<i>Anopheles sp (8.6)</i>	-	R	-
Family Dixidae			
<i>Dixa spp (2.5)</i>	C	C	-
<i>Dixella spp (4.9)</i>	R	C	-
Family Simuliidae			
<i>Simulium spp (4.9)</i>	C	-	A
Family Tipulidae			
<i>Antocha spp (4.4)</i>	R	-	-
<i>Dicranota spp (0)</i>	-	R	R
<i>Hexatoma spp (3.5)</i>			R
<i>Pseudolimnophila spp (6.2)</i>	R	R	R
<i>Tipula spp (7.5)</i>	R	R	C
DIPTERA; CHIRONOMIDAE			
<i>Brillia flavifrons (5.7)</i>	-	R	-
<i>Chironomus spp (9.3)</i>	-	-	R
<i>Corynoneura spp (5.7)</i>	R	-	R
<i>Nilotanyus spp (4.1)</i>	-	-	R
<i>Parametriocnemus lundbecki (3.7)</i>	C	-	R
<i>Paratendipes albimanus (5.6)</i>	-	R	-
<i>Polypedilum aviceps (3.6)</i>	C	R	A
<i>Polypedilum flavum (5.7)</i>			A
<i>Polypedilum illinoense (8.7)</i>	C	C	R
<i>Polypedilum tritum</i>	R	-	-
<i>Tanytus neopunctipenis</i>	-	-	R
<i>Thienemannimyia group (8.4)</i>	C	R	C
<i>Zavrelimyia spp (6.1)</i>	-	R	-
COLEOPTERA			
Family Dryopidae			
<i>Helichus spp (4.1)</i>	-	R	-
Family Dytiscidae			
<i>Agabus spp (8.9)</i>	-	R	-
<i>Neoporus spp (5.0)</i>	-	R	-
Family Elmidae			
<i>Stenelmis spp (5.6)</i>	R	-	R
Family Gyrinidae			
<i>Dineutus spp (5.0)</i>	-	-	R
ODONATA			
Family Aeshnidae			

<i>Boyeria vinosa</i> (5.6)	-	-	C
Family Calopterygidae			
<i>Calopteryx</i> spp (7.5)	R	C	R
Family Coenagrionidae			
<i>Argia</i> spp (8.3)	-	-	C
OLIGOCHAETA			
Family Naidae			
<i>Pristina</i> spp (7.7)	R	-	C
MEGALOPTERA			
Family Corydalidae			
<i>Nigronia serricornis</i> (4.6)	-	-	C
CRUSTACEA			
Family Asellidae			
<i>Caecidotea</i> spp (8.4)	C	-	C
OTHER TAXA			
Family Vellidae			
<i>Rhagovelia</i> spp	R	-	-
<u>Site</u>	<u>1</u>	<u>2</u>	<u>3</u>
Total Taxa Richness	23	18	27
EPT Taxa Richness	6	2	7
EPT Abundance	46	2	45
Taxa $\leq$ 4.0 Biotic Index	6	2	5
Biotic Index	4.88	5.09	5.71

**Table 8. MY-04 (2018) Taxa list with indications of relative abundance for Sites 1-3. A=Abundant (>10), C=Common (3-9), and R=Rare (1-2).**

<u>Statesville I-3819-A</u>	<u>1</u>	<u>2</u>	<u>3</u>
<u>Taxa / Biotic Index Value</u>			
EPHEMEROPTERA			
Family Baetidae			
<i>Baetis pluto</i> (3.4)	R	-	-
Family Ephemerellidae			
<i>Euryloplella funeralis</i> (2.5)	R	-	-
Family Heptageniidae			
<i>Maccaffertium modestum</i> (5.7)	A	A	A
TRICHOPTERA			
Family Hydropsychidae			
<i>Ceratopsyche sparna</i> (2.5)			
<i>Cheumatopsyche</i> spp (6.6)	C	R	A
<i>Diplectrona modesta</i> (2.3)	A	C	R
<i>Hydropsyche betteni</i> (7.9)	-	-	C

Family Limnephilidae			
<i>Pycnopsyche sp. (2.5)</i>	-	-	R
Family Philopotamidae			
<i>Chimarra spp (3.3)</i>	A	R	C
Family Psychomyiidae			
<i>Lype Diversa (3.9)</i>	-	-	R
MISC DIPTERA			
Family Dixidae			
<i>Dixa spp (2.5)</i>	C	R	R
<i>Dixella spp (4.9)</i>	R	R	-
Dolichopodidae	-	R	-
Family Simuliidae			
<i>Simulium spp (4.9)</i>	R	R	A
Family Tipulidae			
<i>Antocha spp (4.4)</i>	-	-	R
<i>Dicranota spp (0.0)</i>	R	-	R
<i>Pseudolimmophila spp (6.2)</i>	R	-	-
<i>Tipula spp (7.5)</i>	-	-	R
Family Ptychopteridae			
<i>Bitticomorpha</i>	-	R	-
DIPTERA; CHIRONOMIDAE			
<i>Brillia flavifrons (3.9)</i>	-	R	R
<i>Corynoneura spp (5.7)</i>	-	R	-
<i>Parametriocnemus lundbecki (3.7)</i>	-	R	R
<i>Paratanytarsus spp (8.0)</i>	-	R	-
<i>Phaenopscetra obediens gp (6.5)</i>	R	R	-
<i>Polypedilum aviceps (3.6)</i>	-	R	-
<i>Polypedilum flavum (5.7)</i>	-	R	C
<i>Polypedilum illinoense (8.7)</i>	C	R	R
<i>Polypedilum tritum</i>	R	R	R
<i>Rheotanytarsus spp (6.5)</i>			R
<i>Stictochironomus devinctus (5.4)</i>	-	R	-
<i>Thienemaniella spp (6.4)</i>	-	-	R
<i>Thienemannimyia group (8.4)</i>	R	R	C
<i>Tribelos jacundum (5.7)</i>	-	-	R
<i>Tvetenia bavarica gp (E sp 1) (3.6)</i>	-	-	R
COLEOPTERA			
Family Dryopidae			
<i>Helichus spp (4.1)</i>	-	R	R
Family Elmidae			
<i>Macronychus glabratus (4.7)</i>	-	-	R
<i>Stenelmis spp (5.6)</i>	C	C	R
Family Gyrinidae			
<i>Dineutus spp (5.0)</i>	-	-	R
Family Ptilodactylidae			

<i>Anchytarsus bicolor</i> (2.4)	-	-	R
ODONATA			
Family Aeshnidae			
<i>Boyeria vinosa</i> (5.6)	-	R	R
Family Calopterygidae			
<i>Calopteryx spp</i> (7.5)	A	A	-
Family Coenagrionidae			
<i>Argia spp</i> (8.3)	-	-	R
Family Gomphidae			
<i>Gomphus spp</i> (5.9)	-	-	R
<i>Ophiogomphus spp</i> (5.9)	-	-	R
<i>Stylogomphus albistylus</i> (5.0)	-	C	-
OLIGOCHAETA			
Family Naidae			
<i>Nais spp</i> (8.7)	-	-	R
Family Tubificidae			
<i>Immature Tubificidae w/o hair setae</i> (7.1)	-	-	R
CRUSTACEA			
Family Asellidae			
<i>Caecidotea spp</i> (8.4)	R	-	-
Family Cambaridae			
<i>immature crayfish</i> (7.5)	-	-	R
OTHER TAXA			
Family Veliidae			
<i>Rhagovelia spp</i>	-	C	R
<u>Site</u>	<u>1</u>	<u>2</u>	<u>3</u>
Total Taxa Richness	18	26	35
EPT Taxa Richness	6	4	7
EPT Abundance	35	15	29
Biotic Index	4.98	5.71	5.63

**Appendix C.**  
**MY-04 Site Photos**  
**(Sites 1-3)**



**Photo 1. Upstream facing view of Site 1.**



**Photo 2. Downstream facing view of Site 1**



**Photo 3. Downstream facing view of Site 2.**



**Photo 4. Upstream facing view of Site 2.**



**Photo 5. Downstreamstream facing view of site 3.**



**Photo 6. Upstream facing view of Site 3.**

**Appendix D.**  
**Habitat Assessment Field Data Sheet**  
**for Mountain/Piedmont Streams and**  
**Benthos Collection Cards**  
**(Sites 1-3)**